VERIFICATION OF TRANSLATION

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hereby declare that as follows:

1. I am a translator and am familiar with both the English and Japanese languages.

2. I am the translator of the document attached hereto and certify that the document is a true and correct translation of a certified copy of Japanese Patent Application No. 2004-18955 to the best of my knowledge and belief.

Dated this 29th day of January, 2008

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Ref. No.04P00228 : Patent Application No. 2004-18955

[Name of Document] Patent Application

[Reference Number] 04P00228

[Filing Date] January 27, 2004

[To] Commissioner of the Patent Office

[International Classification] H01H 51/22

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[Notification of Fee]

[Deposit Number] 053420

[Payable Fee] 21,000

[List of Submitted Documents]

[Document]	Claims	1
[Document]	Specification	1
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[General Authorization No.] 9004844

[Name of Document] What is claimed is:

[Claim 1] A micro relay including a base substrate having a storing portion formed for accommodating an electromagnetic device adapted to generate a flux in response to an exciting current supplied to a coil wound around a yoke and provided with a fixed contact on its one surface in the thickness direction; an armature block having a frame portion to be fixedly secured to said one surface of the base substrate, an armature disposed inside the frame portion, swingably supported by the frame portion through a supporting spring portion and actuated by the electromagnetic device, and a movable contact base portion supported by the armature through a contact pressing spring portion and provided with a movable contact; and a cover having its peripheral portion fixedly secured to the frame portion on the side opposed to the base substrate in the armature block, wherein the electromagnetic device comprises a permanent magnet provided in a magnetic path defined by the armature and the yoke within a thickness dimension of the base substrate.

[Claim 2] A micro relay as set forth in claim 1, wherein said yoke is provided with an elongate coil winding portion around which said coil is wound, a pair of leg pieces extended from both end portions of the coil winding portion respectively in the direction approaching said armature and having leading end portion adapted to be magnetized to opposite poles in response to the exciting current to said coil, and said permanent magnet is disposed at a longitudinal central portion of the coil winding portion in a piled manner on the side of said armature so that its opposite surfaces in the piling direction can be magnetized to opposite poles.

[Claim 3] A micro relay as set forth in claim 1 or 2, wherein

32 Supporting spring

34 Movable contact base portion

35 Contact pressing spring portion

[Name of the Document] ABSTRACT

[Summary]

[Task] It is to provide a micro relay which has an armature, a fixed contact and a movable contact arranged within a hermetically sealed space and of which thickness dimension can be reduced as a whole.

[Solving Means] A micro relay has a base substrate 1 comprising a storing portion for storing an electromagnetic device 2 and fixed contacts 14 arranged on one surface side in the thickness direction, an armature block 3 comprising a frame portion 31 adapted to be fixedly secured to the one surface side of the base substrate 1, an armature 30 arranged inside the frame portion 31, supported swingably by the frame portion 31 through supporting spring portions 32 and actuated by the electromagnetic device 2, and a cover 4 comprising a peripheral portion adapted to be fixedly secured to the frame portion 31 of the armature block 3 on the opposed side to the base substrate 1. The electromagnetic device 2 has a permanent magnet 2 disposed within a magnetic path defined by the armature 30 and a yoke 20 within a thickness dimension of the base substrate 1.

[Selected Drawing] Fig.1

a metallic thin film for coupling is interposed between said frame portion and said base substrate and between said frame portion and said cover respectively entirely around said frame portion.

[Claim 4] A micro relay as set forth in any one of claims 1 through 3, wherein said base substrate is provided with a coupling electrode formed on the other surface side in the thickness direction, a conductive layer for electrically connecting the coupling electrode and said fixedly contact which covers an inner surrounding surface of a through-hole formed therein in the thickness direction, and a closing means for closing the through-hole.

[Claim 5] A micro relay as set forth in claim 4, wherein said closing means is a lid member composed of a silicon thin film fixedly secured to said base substrate so as to close an opening of said through-hole on said one surface side of said base substrate.

[Claim 6] A micro relay as set forth in any one of claims 1 through 5, wherein said armature is composed of a thin plate-like movable base portion supported by the frame portion through said supporting spring portion disposed inside said frame portion and a thin plate-like magnetic member portion composed of a magnetic material fixedly secured to on said electromagnetic device side in the movable base portion, while said armature block has said frame portion, said supporting spring portion, the movable base portion, said contact pressing spring portion and said movable contact base portion formed by working a sheet of semiconductor substrate.

[Claim 7] A method for manufacturing a micro relay as set forth in any one of claims 1 through 6, said method comprising

an armature block forming step in which an armature block is formed by fixedly securing a magnetic member portion composed of a magnetic member to one surface of a movable contact base portion on a base substrate side after the movable base portion constructing portions of a frame portion, a supporting spring portion, a contact pressing spring portion, a movable contact base portion and an armature has been formed by working a semiconductor substrate as well as by fixedly securing a movable contact to the movable contact base portion, a sealing step in which a space surrounded by a base substrate, a cover and a frame portion of the armature block is hermetically sealed by fixedly securing the movable contact to the armature block formed in the armature block step to the base substrate and a cover, and an electromagnetic device arrangement step in which an electromagnetic device is accommodated in a storing portion of the base substrate after the hermetically sealing step.

[Claim 8] A method for manufacturing a micro relay as set forth in claim 5, said method comprising an armature block forming step in which an armature block is formed by fixedly securing a magnetic member portion composed of a magnetic member to one surface of a movable contact base portion on a base substrate side after the movable base portion constructing portions of a frame portion, a supporting spring portion, a contact pressing spring portion, a movable contact base portion and an armature has been formed by working a semiconductor substrate as well as by fixedly securing a movable contact to the movable contact base portion, a sealing step in which a space surrounded by a base substrate, a cover, a frame portion of the armature block is hermetically sealed by fixedly securing the movable contact to the armature block formed in the armature

block step to the base substrate and a cover, and an electromagnetic device arrangement step in which an electromagnetic device is accommodated in a storing portion of the base substrate after the hermetically sealing step, wherein when forming the base substrate, after a through-hole has been formed simultaneously with the forming of a storing hole passing through a location corresponding to a storing portion in a substrate as a base of the base substrate in the thickness direction, a thin film for covering both the storing hole and the through-hole is fixedly secured to a surface of the substrate on the fixed contact side as well as a plurality of lid members for closing respective openings of the storing hole and the through-hole separately are formed by patterning the thin film.

[Name of Document] SPECIFICATION

[Title of the Invention] MICRO RELAY AND METHOD FOR MANUFACTURING THE SAME

[Technical Field]

[0001]

The present invention relates to a micro relay and a method for manufacturing the micro relay.

[Background Art]

[0002]

Conventionally has been known such a micro relay having contacts opened and closed by actuating an armature utilizing an electromagnetic force of an electromagnetic device, as a micro relay which is capable of increasing an actuating force in comparison to a micro relay of the electrostatic actuating type (for example, refer to the Patent Document 1).

[0003]

Herein, the micro relay disclosed in the above-mentioned Patent Document 1 has a base substrate composed of a rectangular ceramic substrate having a pair of fixed contacts provided at its opposed end portions in its longitudinal direction respectively on one surface side in its thickness direction and two insertion holes into which two electromagnetic devices are inserted, separated from each other in its longitudinal direction, an armature block having an armature provided with a rectangular frame portion and permanent magnets disposed inside the frame portion, swingably supported by the frame portion through a pair of pivot portions and arranged at locations opposed to the respective electromagnetic devices, and a rectangular frame-like spacer interposed between a peripheral portion of the base substrate and the frame portion of the armature block. Incidentally, since the micro relay disclosed in the above-mentioned Patent Document 1 can have a larger actuating force in comparison with the micro relay of the electrostatic actuating type, advantageously it becomes possible to increase an actuating stroke of the armature so as to increase a distance between the movable contact and the fixed contact at the time of contact opening and to improve a high frequency characteristic (an isolation characteristic) as well as to enable a low-voltage actuation.

[Patent Document 1] Japanese Non-examined Patent Document No. 5-114347 (refer to Paragraphs No.[0033] - [0036], Figs. 11 -13)

[Disclosure of Invention]

[Tasks to be Solved by the Invention]

[0004]

On the other hand, in the micro relay disclosed in the Patent Document 1, since the two permanent magnets are arranged in the surfaces of the armature opposed to the respective electromagnetic devices and it is necessary to interpose the spacer having a comparatively larger thickness dimension between the peripheral portion of the base substrate and the frame portion of the armature block, a thickness dimension of the whole of the relay becomes large. Further, in the micro relay disclosed in the Patent Document 1, since it is apprehended that the armature, the fixed contact and the movable contact are exposed to the open air and oxidized and/or foreign materials enter between the fixed contact and the movable contact, it is desired to arrange the armature, the fixed contact and the movable contact within the hermetically sealed space.

[0005]

The present invention is directed to solving the above-mentioned problems and has for its object to provide a micro relay which has an armature, a fixed contact and a movable contact arranged within a hermetically sealed space and which is capable of decreasing a thickness dimension on the whole and to provide a manufacturing method thereof.

[Means for Solving Tasks]

[0006]

The invention of claim 1 resides in a micro relay including a base substrate having a storing portion formed for accommodating an electromagnetic device adapted to generate a flux in response to an exciting current supplied to a coil wound around a yoke and provided with a fixed contact on its one surface in the thickness direction; an armature block having a

frame portion to be fixedly secured to said one surface of the base substrate, an armature disposed inside the frame portion, swingably supported by the frame portion through a supporting spring portion and actuated by the electromagnetic device, and a movable contact base portion supported by the armature through a contact pressing spring portion and provided with a movable contact; and a cover having its peripheral portion fixedly secured to the frame portion on the side opposed to the base substrate in the armature block, wherein the electromagnetic device comprises a permanent magnet provided in a magnetic path defined by the armature and the yoke within a thickness dimension of the base substrate.

[0007]

According to this invention, since there is the cover a peripheral portion of which is fixedly secured to the frame portion on the opposed side to the base substrate in the armature block so that the armature, the fixed contact and the movable contact are arranged within the hermetically sealed space as well as the electromagnetic device has the permanent magnet disposed within the magnetic path defined by the armature and the yoke within a thickness dimension of the base substrate, it becomes unnecessary to interpose a conventionally required space between the armature block and the base substrate so that the thinning of the whole of the relay becomes possible.

[0008]

According to the invention of claim 2, in the invention of claim 1, said yoke is provided with an elongate coil winding portion around which said coil is wound, a pair of leg pieces extended from both end portions of the coil winding portion respectively in the direction approaching said armature and

having leading end portion adapted to be magnetized to opposite poles in response to the exciting current to said coil, and said permanent magnet is disposed at a longitudinal central portion of the coil winding portion in a piled manner on the side of said armature so that its opposite surfaces in the piling direction can be magnetized to opposite poles.

[0009]

According to this invention, the armature becomes able to swing about a central portion of the armature in its longitudinal direction and thus its impact resistance is improved.

[0010]

According to the invention of claim 3, in the invention of claim 1 or 2, a metallic thin film for coupling is interposed between said frame portion and said base substrate and between said frame portion and said cover respectively entirely around said frame portion.

[0011]

According to this invention, it becomes possible to improve the hermetical capability of the space defined by the base substrate, the cover and the frame portion.

[0012]

According to the invention of claim 4, in the invention of any one of claims 1 through 3, said base substrate is provided with a coupling electrode formed on the other surface side in the thickness direction, a conductive layer for electrically connecting the coupling electrode and said fixedly contact which covers an inner surrounding surface of a through-hole formed therein in the thickness direction, and a closing means for closing the through-hole.

[0013]

According to this invention, it becomes possible to prevent unnecessary gas and/or foreign materials from entering into an interior space through the through-hole from outside and to prevent the lowering of the contact reliability which might be caused by oxidization of the surfaces of the fixed contact and/or the movable contact or intrusion of foreign materials. Further, it becomes possible to change an operation speed of the armature by optionally setting an atmospheric pressure within the interior space. For example, in the case of application to a high operation speed of the relay, a pressure within the interior space may be set to a comparatively low pressure, and in the case of application to that the contact bounce is required to be decreased while the low operation speed is allowed, a pressure within the interior space may be set to a comparatively high pressure.

[0014]

According to the invention of claim 5, in the invention of claim 4, said closing means is a lid member composed of a silicon thin film fixedly secured to said base substrate so as to close an opening of said through-hole on said one surface side of said base substrate.

[0015]

According to this invention, it becomes possible to readily and stably close the opening of the through-hole.

[0016]

According to the invention of claim 6, in the invention of any one of claims 1 through 5, said armature is composed of a thin plate-like movable base portion supported by the frame portion through said supporting spring portion disposed inside said frame portion and a thin plate-like magnetic member portion

composed of a magnetic material fixedly secured to on said electromagnetic device side in the movable base portion, while said armature block has said frame portion, said supporting spring portion, the movable base portion, said contact pressing spring portion and said movable contact base portion formed by working a sheet of semiconductor substrate.

[0017]

According to this invention, it becomes possible to form the most of the armature block by applying the micromachining technology of the semiconductor to the semiconductor substrate and thus to improve mechanical service lives of the supporting spring portion and the contact pressing spring portion.

[0018]

The invention of claim 7 resides in a method for manufacturing a micro relay as set forth in any one of claims 1 through 6, said method comprising an armature block forming step in which an armature block is formed by fixedly securing a magnetic member portion composed of a magnetic member to one surface of a movable contact base portion on a base substrate side after the movable base portion constructing portions of a frame portion, a supporting spring portion, a contact pressing spring portion, a movable contact base portion and an armature has been formed by working a semiconductor substrate as well as by fixedly securing a movable contact to the movable contact base portion, a sealing step in which a space surrounded by a base substrate, a cover and a frame portion of the armature block is hermetically sealed by fixedly securing the movable contact to the armature block formed in the armature block step to the base substrate and a cover, and an electromagnetic device arrangement step in which an electromagnetic device is

accommodated in a storing portion of the base substrate after the hermetically sealing step.

[0019]

According to this invention, it becomes possible to provide a micro relay which is capable of arranging the armature, the fixed contact and the movable contact within the hermetically sealed space and which is capable of thinning the whole of the relay.

[0020]

The invention of claim 7 resides in a method for manufacturing a micro relay as set forth in claim 5, said method comprising an armature block forming step in which an armature block is formed by fixedly securing a magnetic member portion composed of a magnetic member to one surface of a movable contact base portion on a base substrate side after the movable base portion constructing portions of a frame portion, a supporting spring portion, a contact pressing spring portion, a movable contact base portion and an armature has been formed by working a semiconductor substrate as well as by fixedly securing a movable contact to the movable contact base portion, a sealing step in which a space surrounded by a base substrate, a cover, a frame portion of the armature block is hermetically sealed by fixedly securing the movable contact to the armature block formed in the armature block step to the base substrate and a cover, and an electromagnetic device arrangement step in which an electromagnetic device is accommodated in a storing portion of the base substrate after the hermetically sealing step, wherein when forming the base substrate, after a through-hole has been formed simultaneously with the forming of a storing hole passing through a location corresponding to a storing portion in a substrate as a base of the base substrate in the

thickness direction, a thin film for covering both the storing hole and the through-hole is fixedly secured to a surface of the substrate on the fixed contact side as well as a plurality of lid members for closing respective openings of the storing hole and the through-hole separately are formed by patterning the thin film.

[0021]

According to this invention, it becomes possible to provide a micro relay which is capable of arranging the armature, the fixed contact and the movable contact within the hermetically sealed space and which is capable of thinning the whole of the relay. In addition thereto, since the storing hole and the through-hole can be closed simultaneously, it becomes possible to reduce the number of steps and thus to attain the cost reduction in comparison with the case in which they are closed in separate steps.

[Advantages of the Invention]

[0022]

According to the invention of claim 1, advantageously the armature, the fixed contact and the movable contact can be arranged within the hermetically sealed space and the thinning of the whole of the relay becomes possible.

[0023]

According to the invention of claim 7, advantageously the armature, the fixed contact and the movable contact can be arranged within the hermetically sealed space and the thinning of the whole of the relay becomes possible.

[0024]

According to the invention of claim 8, advantageously it becomes possible to provide a micro relay which is capable of

arranging the armature, the fixed contact and the movable contact within the hermetically sealed space and which is capable of thinning of the whole of the relay becomes possible.

[0025]

According to the invention of claim 8, advantageously it becomes possible to provide a micro relay which is capable of arranging the armature, the fixed contact and the movable contact within the hermetically sealed space and which is capable of thinning of the whole of the relay becomes possible. Further, since the storing hole and the through-hole can be closed simultaneously, it becomes possible to reduce the number of steps and thus to attain the cost reduction in comparison with the case in which they are closed in separate steps.

[Best Mode for Carrying out the Invention]

[0025]

A micro relay according to an embodiment of the present invention will be explained with reference to Fig. 1 to Fig. 7 hereinafter.

[0026]

A micro relay according to this embodiment has an electromagnetic device 2 for generating a magnetic flux in response to an exciting current supplied to coils 22, 22 wound around a yoke 20; a base substrate 1 composed of a rectangular plate-like glass substrate and provided with a pair of fixed contacts 14 at opposed end portions in its longitudinal direction respectively on a one surface side in its thickness direction; an armature block 3 having a frame-like (rectangular frame-like) frame portion 31 fixedly secured to the one surface side of the base substrate 1, an armature 30 disposed inside the frame portion 31, supported swingably by the frame portion 31 through

four sets of supporting spring portions 32 and actuated by an electromagnetic device 2, and two sets of movable contact base portions 34 supported by the armature 30 through two sets of contact and pressing portions 35 respectively and provided with a movable contact 39 respectively; and a cover 4 composed of a rectangular glass substrate a peripheral portion of which is fixedly secured to the frame portion 31 on the opposed side of the armature block 3 to the base substrate 1.

[0027]

The yoke 20 in the electromagnetic device 2 has an elongate rectangular plate-like coil winding portion 20a around which the two sets of coils 22, 22 are wound directly, a pair of leg pieces 20b, 20b extended from the longitudinally opposed end portions of the coil winding portion 20a in the directions approaching the armature 30 respectively and having their leading end surfaces adapted to be excited so as to be polarized differently to each other in response to an exciting current supplied to the coils 22, 22, a rectangular plate-like permanent magnet 21 put onto the longitudinally middle portion of the coil winding portion 20a of the yoke 20 between the opposed leg pieces 20b, 20b, and a rectangular plate-like printed board 23 fixedly secured to the coil winding portion 20a so as to be orthogonal to the coil winding portion 20a on the opposed side of the coil winding portion 20a of the yoke 20 to the surface onto which the permanent magnet 21 is put. Incidentally, the yoke 20 is formed by bending an iron plate of, such as an electromagnetic soft iron or by casting it so that a cross-section of both the leg pieces 20b, 20b can be formed in the rectangular shape.

[0028]

The permanent magnet 21 has magnetic pole surfaces 21a,

21b formed by the opposed surfaces thereof in the piling direction (the thickness direction) with respect to the coil winding portion 20a and adapted to be magnetized differently and its thickness dimension defined so that one of the magnetic pole surfaces 21b can be brought into contact with the coil winding portion 20a of the yoke 20 and the other magnetic pole surface 21a can be positioned so as to be coplanar with the leading end surfaces of both the leg pieces 20b, 20b of the yoke 20. Incidentally, an arrow A in Fig. 4 indicates magnetizing directions.

[0029]

The moving of the respective coils 22, 22 in the direction of □ axis (namely in the longitudinal direction of the coil winding portion 20a) is restricted by the permanent magnet 21 and the leg pieces 20b, 20b of the yoke 20. The printed board 23 has conductive patterns 23b formed at opposed end portions of one surface of an insulating substrate 23a in its longitudinal direction, while a circular portion in each conductive pattern 23b constructs an external connecting electrode and a rectangular portion constructs a coil connection portion. Herein, distal ends of the coils 22, 22 are connected to the coil connection portion, and the coils 22, 22 are connected so that the leading end surfaces of both the leg pieces 20b, 20b of the yoke 20 can be magnetized differently each other when an exciting current is supplied from an electric power source connected between the external connecting electrodes to the coils 22, 22. Incidentally, though a bump 24 made from a conductive material (for example, Au, Ag, Cu, solder or the likes) is fixedly secured to the external connecting electrode in each conductive pattern 23b, a bonding wire may be bonded thereto instead that the bump 24

is fixedly secured thereto.

[0030]

The base substrate 1 is formed of heat resistance glass such as Pyrex (R) such that it has a rectangular outer periphery, a storing hole 16 formed for storing the electromagnetic magnet 2 so as to pass through the central portion in the thickness direction, and through-holes 10 formed at respective locations near to its four corners so as to pass through each location in the thickness direction. A land 12 is formed at a surrounding edge of each through-hole 10 in the opposed surfaces of the base substrate 1 in the thickness direction. Herein, the lands 12 coincident to each other in the thickness direction of the base substrate 1 is electrically connected to each other by a conductive layer (not illustrated) made of conductive material (for example, Cu, Cr, Ti, Pt, Co, Ni, Au or an alloy thereof) covering an inner surrounding surface of the through-hole 10. A bump 13 is optionally fixedly secured to each land 12 on the other surface side of the base substrate 1 in the thickness direction, and thus by fixedly securing the bump 13 to the land 12, the opening of the through-hole 10 is covered by the bump 13 on the above-mentioned other surface side of the base substrate 1. The opening of the through-hole 10 is circular, while lid members 19 composed of four sheets of silicon thin films are fixedly secured to the above-mentioned one surface of the base substrate 1 so as to cover the openings of through-holes 10 and the lands 12 respectively.

[0031]

The above-mentioned respective pairs of fixed contacts 14 are arranged in parallel in the latitudinal direction between the two through-holes 10 formed so as to be separated from each

other in the latitudinal direction of the base substrate 1 in the opposed end portions of the base substrate 1 in the longitudinal direction and are electrically connected through the conductive patterns 18 to the lands 12 formed around the peripheral edges of the through-holes 10 arranged adjacently to each other in the latitudinal direction. Herein, as a material of the fixed contact 14, the conductive pattern 18 and the land 12 may be employed a conductive material, for example such as Cr, Ti, Pt, Co, Cu, Ni, Au or an alloy thereof. As a material of the bump 13 may be employed a conductive material, for example such as Au, Ag, Cu or solder. Incidentally, the above-mentioned through-holes 10 and storing hole 16 may be formed, for example by a sand blasting method or an etching method, while the above-mentioned conductive layer may be formed, for example by a plating method, a vaporizing method or a spattering method. Incidentally, in this embodiment, the lid members 19 construct closing means for closing the openings of the through-holes 10 and the lands 12 on the other surface side of the base substrate 1 constructs connecting electrodes.

[0032]

An opening of the storing hole 16 is formed like a cross and a lid member 17 made of a silicon thin film for closing the storing hole 16 is fixedly secured to the above-mentioned one surface side of the base substrate 1. That is, the electromagnetic device 2 is inserted into the storing hole 16 so that the respective leading end surfaces of both the leg pieces 20b, 20b of the yoke 20 oppose to the lid member 17. Incidentally, in this embodiment, a space defined by the inner surrounding surface of the storing hole 16 and the lid member 17 constructs a storing portion for accommodating the electromagnetic device 2, while

the electromagnetic device 2 has the permanent magnet 21 disposed in a magnetic path defined by the armature 30 and the yoke 20 within a thickness dimension of the base substrate 1 as well as a surface of the insulating substrate 23a in the printed board 23 is substantially coplanar with the above-mentioned other surface of the base substrate 1. Incidentally, the lid members 17, 19 are constructed by a silicon thin film formed by thinning a silicon board with etching, grinding or the like so as to have a thickness dimension of 20 μm. Herein, the thickness dimension is not limited to 20 μm, but it may be optionally set to, for example a range of 5 μm to 50 μm around. Further, a material of the lid members 17, 19 is not limited to the silicon thin film, but also a glass thin film formed, for example by thinning a glass board by means of etching or grinding may be used.

[0033]

The storing hole 16 has a tapering shape in which an opening area gets gradually larger from the above-mentioned one surface of the base substrate 1 to the above-mentioned other surface thereof, so that the electromagnetic device 2 can be inserted readily into the storing hole 16 as well as the opening area in the above-mentioned one surface of the base substrate 1 can be made comparatively smaller.

[0034]

In the armature block 3, the above-mentioned rectangular frame-like frame portion 31, the above-mentioned four pieces of supporting springs 32, the rectangular movable base portion 30a which constructs one portion of the armature 30 arranged inside the frame portion 31, the above-mentioned four pieces of contact pressing springs 35, and the above-mentioned two movable

contact base portions 34 are formed by applying a semiconductor micromachining process to a semiconductor substrate composed of a silicon substrate, while the armature 30 is constructed by the movable base portion 30a and a rectangular plate-like magnetic member portion 30b composed of a magnetic member (for example, soft magnetic iron, magnetic stainless, Permalloy or the like) fixedly secured to an opposed surface of the movable base portion 34 to the base substrate 1. Therefore, the armature 30 is supported swingably by the frame portion 31 through the four pieces of supporting springs 32. Incidentally, the movable base portion 30a is thinner than the frame portion 31, while a thickness dimension of the armature 30 is so set that a predetermined gap can be formed between the magnetic member portion 30b and of the armature 30 and the lid member 17 under such a condition that the armature block 3 and the base substrate 1 are fixedly secured to each other.

[0035]

The above-mentioned supporting spring portions 32 are provided at two locations separated in the longitudinal direction in the movable base portion 30a on the opposed sides of the movable base portion 30a in the latitudinal direction. Each supporting spring portion 32 has its one end portion connected integrally to the frame portion 31 and its other end portion connected integrally to the movable base portion 30a. Incidentally, each supporting spring portion 32 has its length dimension increased by making it meander in a coplanar manner between above-mentioned one end portion and the above-mentioned other end portion in a plan view, so that stress imposed to each supporting spring portion 32 can be dispersed at the time of swinging of the armature 30 and thus breakage of

each supporting spring portion 32 can be prevented.

[0036]

The movable base portion 30a has rectangular projecting pieces 36 integrally extended from middle portions of its opposed side edges in the latitudinal direction, and the frame portion 31 also has rectangular projecting pieces 37 integrally extended from its inner surrounding surface at locations corresponding to the projecting pieces 36. That is, the projecting pieces 36 extended from the movable base portion 30a and the projecting pieces 37 extended from the frame portion 31 have their leading end surfaces opposed to each other. In this case, each projecting piece 36 extended from the movable base portion 30a has a convex portion 36a formed in the leading end surface, and each projecting piece 37 extended from the frame portion 31 has a concave portion 37a formed in the leading end surface so as to receive the convex portion 36a. Therefore, since the convex portions 36a are in contact with the inner peripheral surfaces of the concave portions 37a, the movement of the armature 30 in a plane orthogonal to the thickness direction of the frame portion 31 is restricted. On the other hand, the two supporting springs 32 arranged on the same side edge side of the armature 30 are located on both sides with respect to the projecting piece 36.

[0037]

Further, the armature block 3 has the movable contact base portions 34 arranged between the opposed end portions of the armature 30 and the frame portion 31 in the longitudinal direction of the armature 30, and each movable contact base portion 34 has a movable contact 39 made of a conductive material and formed in its opposed surface to the base substrate 1. Herein, the movable contact base portion 34 is supported by

the movable base portion 30a through the above-mentioned two pieces of contact pressing spring portions 35. Incidentally, the movable base portion 30a is formed like a rectangular plate as mentioned above with stopper portions 33 extended continuously and integrally from four corners respectively for limiting a displacement of a magnetic member portion 30b, and a shape of the contact pressing spring portion 35 in a plan view is like a ㄱ -letter running along three sides of an outer peripheral edge of the stopper portion 33. When these stopper portions 33 are brought into contact with the one surface of the base substrate 1, a displacement of the magnetic member portion 30b is limited.

[0038]

As clearly understood, the armature block 3 has the frame portion 31, the movable base portion 30a, the supporting spring portions 32, the movable contact holding portions 34 and the contact pressing spring portions 35 constructed by portions of the above-mentioned semiconductor substrate. As the semiconductor substrate, for example a silicon substrate having a thickness dimension of 200 μm around may be used. But, the thickness dimension is not limited particularly, for example it may be optionally set to such a range as being 50 μm to 300 μm around.

[0039]

Further, also a total dimension of the thickness dimension of the movable contact base portion 34 and the thickness dimension of the movable contact 39 is set so that a distance between the movable contact 39 and the fixed contact 14 becomes a predetermined distance.

[0040]

The cover 4 is formed by heat resistance glass such as Pyrex

(R) and has a concave portion 4a formed in a surface opposed to the armature block 3 to secure a swinging space for the armature 30.

[0041]

By the way, a connecting metallic thin film 38b is formed in an entire surrounding portion of the opposed surface of the frame portion 31 of the armature block 3 to the base substrate 1, while a connecting metallic thin film 38a is formed in an entire surrounding portion of the opposed surface thereof to the cover 4. A connecting metal thin film 15 is formed also in an entire surrounding portion of the opposed surface of the base substrate 1 to the armature block 3, and a connecting metallic thin film 42 is formed also in an entire surrounding portion of the opposed surface of the cover 4 to the armature block 3. Therefore, it becomes possible to hermetically connect the cover 4 and the base substrate 1 to the armature block 3 by pressing connection or anodic connection and thus to improve a hermetically sealing capability of the space surrounded by the base substrate 1, the cover 4 and the frame portion 31.

[0042]

As a result, the micro relay according to this embodiment has the armature 30, the movable contact 33 and the fixed contact 14 accommodated within the hermetically sealed space surrounded by the base substrate 1, the cover 4 and the frame portion 31 interposed between the base substrate 1 and the cover 4. Incidentally, as a material of the above-mentioned connecting metallic thin films 15, 38a, 38b, 42 may be employed, for example Au, Al-Si or the like.

[0043]

When mounting the above-explained micro relay according

to this embodiment to a mount board such as a printed board, for example the two pieces of bumps 24 and four pieces of bumps 13 exposed on the other surface side of the base substrate 1 may be connected to the conductive pattern formed on one surface side of the above-mentioned mount board respectively.

[0044]

Next, a method for manufacturing the micro relay according to this embodiment will be explained in brief.

[0045]

For manufacturing the micro relay according to this embodiment, there are an armature block forming step in which the armature block 3 is formed by fixedly securing the magnetic member portion 30b composed of the magnetic member to one surface of the movable base portion 30a on the side of the base substrate 1 and fixedly securing the movable contacts 39 to the movable contact base portions 34 after the frame portion 31, the supporting spring portions 32, the contact pressing spring portions 35, the movable contact base portions 34 and the movable base portion 30a which constructs a portion of the armature 30 have been formed by working the silicon substrate as the semiconductor substrate using the semiconductor micromachining process (the micromachining technology) such as a lithography technology, an etching technology or the likes, a hermetically sealing step for hermetically sealing the space surrounded by the base substrate 1, the cover 4, the frame portion 31 of the armature block 3 by fixedly securing the cover 4 and the base substrate 1 to the armature block 3 formed in the armature block forming step by means of the pressing connection or the anodic connection, and an electromagnetic device arrangement step in which the electromagnetic device 2 is

accommodated within the storing portion of the base substrate 1 and fixedly secured to the base substrate 1 after the hermetically sealing step.

[0046]

Herein, when forming the base substrate 1, the storing hole 16 is formed in the glass substrate as a base substrate for the base substrate 1 so as to pass through a location corresponding to the storing portion in the thickness direction as well as through-holes 10 are formed so as to pass through locations near to the four corners of the glass substrate in the thickness direction, and then a thin film (for example a silicon thin film, a glass thin film or the like) for covering both the storing hole 16 and the through-holes 10 is fixedly securing to the surface of the glass substrate on the side of the fixed contacts 14 and then the lid members 17, 19 for individually closing the respective openings of the storing hole 16 and the through-holes 10 are formed by patterning the above-mentioned thin film after the lands 12, the fixed contacts 14, the conductive patterns 18 and the conductive layer have been formed. Incidentally, the storing hole 16 and the through-holes 10 can be formed by the etching method, the sand-blasting method or the like.

[0047]

When forming the cover 4, the connecting metallic thin film 42 can be formed after the concave portion 4a has been formed in a glass substrate as a base substrate for the cover 4. Herein, the concave portion 4a can be formed by the etching method, the sand-blasting method or the like.

[0048]

By the way, in this embodiment, the base substrate 1 and the cover 4 are formed by working the glass substrate respectively.

But, one or both of the base substrate 1 and the cover 4 may be formed by working the silicon substrate. If substrates for the base substrate 1 and the cover 4 are limited to the glass substrate and a semiconductor board for the armature block 3 is limited to a silicon board, it becomes possible to hermetically connect the base substrate 1 and the cover 4 to the armature block 3 by means of the anodic connection without using the connecting metallic thin films 15, 38a, 38b, 42. Incidentally, of course it is possible to fixedly secure a wafer having the above-mentioned many base substrates 1 formed thereon and a wafer having the above-mentioned many covers 4 formed thereon to a wafer having the above-mentioned many armature blocks 3 formed thereon by means of the contact pressing process or the anodic connection process and then to divide the fixedly secured wafers into individual micro relays by means of a dicing process or the like.

[0049]

An operation of the micro relay according to this embodiment will be explained hereinafter.

[0050]

In the micro relay according to this embodiment, when an electricity is supplied to the coils 22, 22, one end portion of the magnetic member portion 30b in the longitudinal direction is attracted by one of the leg pieces 20b of the yoke 20 depending on the magnetization direction, and then the armature 30 is made swing, so that the movable contact 39 fixedly secured to the movable contact base portion 34 of the armature 30 on one end side is brought into contact with the pair of corresponding fixed contacts 14, 14 with a predetermined degree of contact pressure. Even when the electricity supply is stopped in this condition,

since the attraction force is maintained by magnetic flux generated by the permanent magnet 21, that condition is held as it is.

[0051]

When the direction of the electricity supply to the coils 22, 22 is reversed, the magnetic member portion 30b of the armature 30 is attracted by the other leg piece 20b of the yoke 20, and then the armature 30 is made swing, so that the movable contact 39 held by the movable contact base portion 34 of the armature 30 on the other end side is brought into contact with the pair of corresponding fixed contacts 14, 14 with a predetermined degree of contact pressure. Even when the electricity supply is stopped in this condition, since the attraction force is maintained by magnetic flux generated by the permanent magnet 21, that condition is held as it is.

[0052]

Incidentally, in the micro relay of this embodiment, a spring constant of the supporting springs 32 is set so that the attraction force of the permanent magnet 21 for the magnetic member portion 30b becomes stronger than a returning force of the supporting springs 32. But, the spring constant of the supporting springs 32 may be set so that the attraction force of the permanent magnet 21 for the magnetic member portion 30b becomes weaker than the returning force of the supporting springs 32.

[0053]

According to the micro relay of the above-explained embodiment, since the armature block 3 has the cover 4 fixedly secured to the frame portion 31 at their peripheral portions on the opposed side to the base substrate 1, the armature, the fixed

contacts 14 and movable contacts 39 are accommodated within the hermetically sealed space as well as the electromagnetic device 2 has the permanent magnet 21 arranged in the magnetic path defined by the armature 30 and the yoke 20 within the thickness dimension of the base substrate 1. Therefore, differently from the conventional embodiment, it is unnecessary to interpose a spacer between the armature block and the base substrate and thus it becomes possible to decrease the thickness dimension of the whole of the relay. That is, since the thickness dimension of the whole of the relay can be defined as a total dimension of the thickness dimension of the base substrate 1, the thickness dimension of the frame portion 31 of the armature block 3 and the thickness dimension of the cover 4, it becomes possible to decrease a thickness dimension of an instrument body composed of the base substrate 1, the cover 4 and the frame portion 31.

[0054]

Further in the micro relay according to this embodiment, since the permanent magnet 21 is placed onto the coil winding portion 20a at the central portion in its longitudinal direction on the side of the armature 30 and the opposed surfaces in the stacking direction are magnetized to different polarities, the armature 30 becomes able to swing about the central portion in the longitudinal direction of the armature 30 and thus its shock resistance becomes improved. In addition thereto, since the fulcrum projections 36b are projected from the opposed surfaces of the respective projecting pieces 36 to the base substrate 1 which are extended from the movable base portion 30a of the armature 30, it becomes possible to make the swinging operation of the armature 30 stable by arranging the pair of fulcrum

projections 36b in that way.

[0055]

By the way, as shown in Fig. 8, in the above-mentioned micro relay, a pair of conic fulcrum projections 17b on which the armature 30 is placed swingably may be provided in a lid member 17. By providing such pair of fulcrum projections 17b, the swinging operation of the armature 30 can be made more stable.

[0056]

By the way, as shown in Fig. 9, in the above-mentioned micro relay, stoppers 17c for limiting a displacement distance of the armature 30 may be projected from locations of the lid member 17 corresponding to the opposed end portions of the magnetic member portion 30b. Also in the case of the arrangement of such stoppers 17c, It becomes possible to prevent breakages of the magnetic member portion 30b or the lid member 17 which might be caused by collision between the magnetic member portion 30b and the lid member 17.

[0057]

Though the above-mentioned example has the stopper portions 33 extended from the four corners of the movable base portions 30a in the armature 30 for preventing the breakage of the magnetic member portion 30b or the lid member 17 which might be caused by the collision between the magnetic member portion 30b of the armature 30 attracted by the magnetic attraction force of the permanent magnet 21 and the lid member 17, as shown in Fig. 10, stoppers 17d made of a metallic film may be formed at opposed locations of the lid member 17 to the opposed end portions of the magnetic member portion 30b. Incidentally, as a material of the metallic film which constructs the stoppers 17d may be employed a metal such as Al, Cu, Cr, Ni,

Au or the like or an alloy thereof.

[0058]

Further, in the above-mentioned micro relay, as shown in Fig. 11, when notch portions 23c, 23c are formed in the opposed end portions of the printed board 23 in the longitudinal direction of the insulating substrate 23a for making the width dimension of the opposed end portions smaller in comparison with that of other portions, it becomes easy to carry out the winding process of end portions of the coils 22, 22.

[0059]

Further, in the above-mentioned micro relay, though the コ-letter like yoke is used as the yoke 20 of the electromagnetic device 2, the yoke 20 is not limited to the コ-letter like yoke, but H-letter like yoke as shown in Fig. 12 may be used as the yoke 20.

[Brief Description of the Drawings]

[0060]

[Fig. 1] It is an exploded perspective view showing an embodiment of the present invention.

[Fig. 2] It is a perspective view showing the same thereof.

[Fig. 3] It is an exploded perspective view of a principal portion thereof.

[Fig. 4] It is an enlarged view of a principal portion thereof.

[Fig. 5] It shows an armature block thereof, and (a) is a plan view and (b) is a bottom view.

[Fig. 6] It is an exploded perspective view of an armature block thereof.

[Fig. 7] It is a perspective view of a cover for use in the same thereof.

[Fig. 8] It is a sectional view of a principal portion of another constructional embodiment thereof.

[Fig. 9] It is a sectional view of a principal portion of still another constructional embodiment thereof.

[Fig. 10] It is an explanatory view of a principal portion of further constructional embodiment thereof.

[Fig. 11] It is a perspective view of a principal portion of still further constructional embodiment thereof.

[Fig. 12] It is an explanatory view of a principal portion of another constructional embodiment thereof.

[Explanation of the Symbol]

[0061]

1 Base substrate
2 Electromagnetic device
3 Armature block
4 Cover
10 Through-hole
14 Fixed contact
16 Storing hole
17 Lid member
20 Yoke
20a Coil winding portion
20b Leg piece
21 Permanent magnet
22 Coil
23 Printed board
30 Armature
30a Movable base portion
30b Magnetic member portion
31 Frame portion

FIG. 2

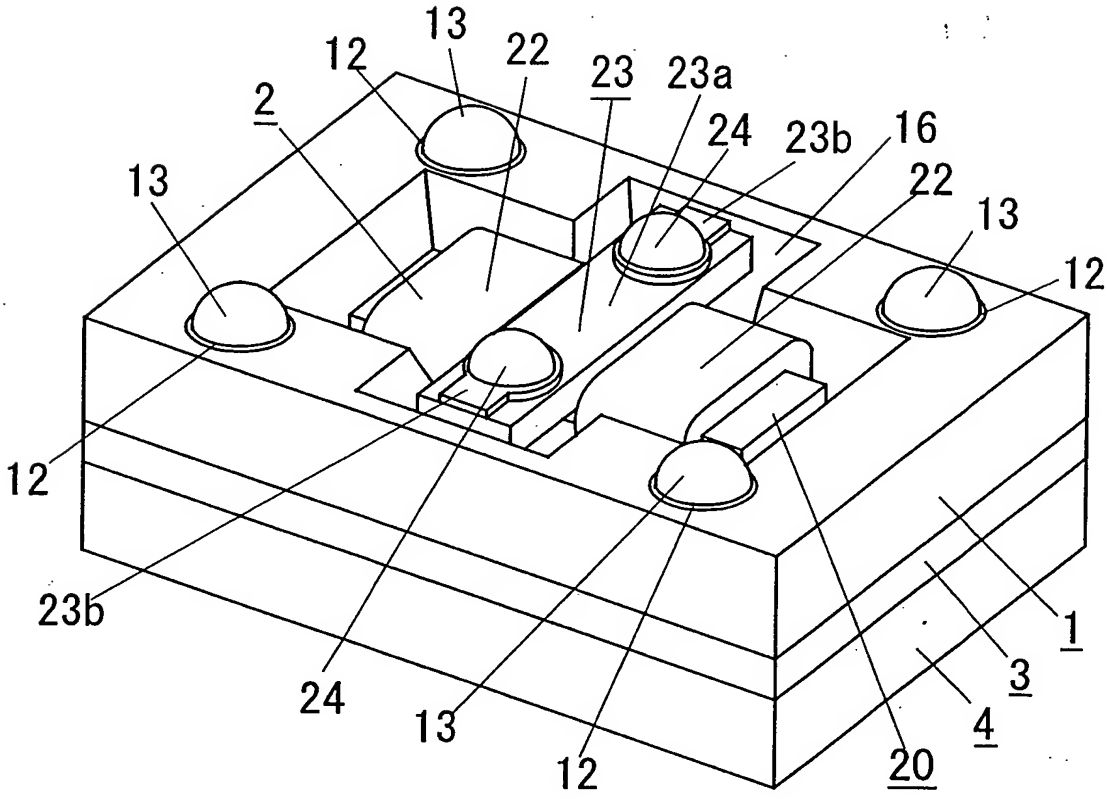
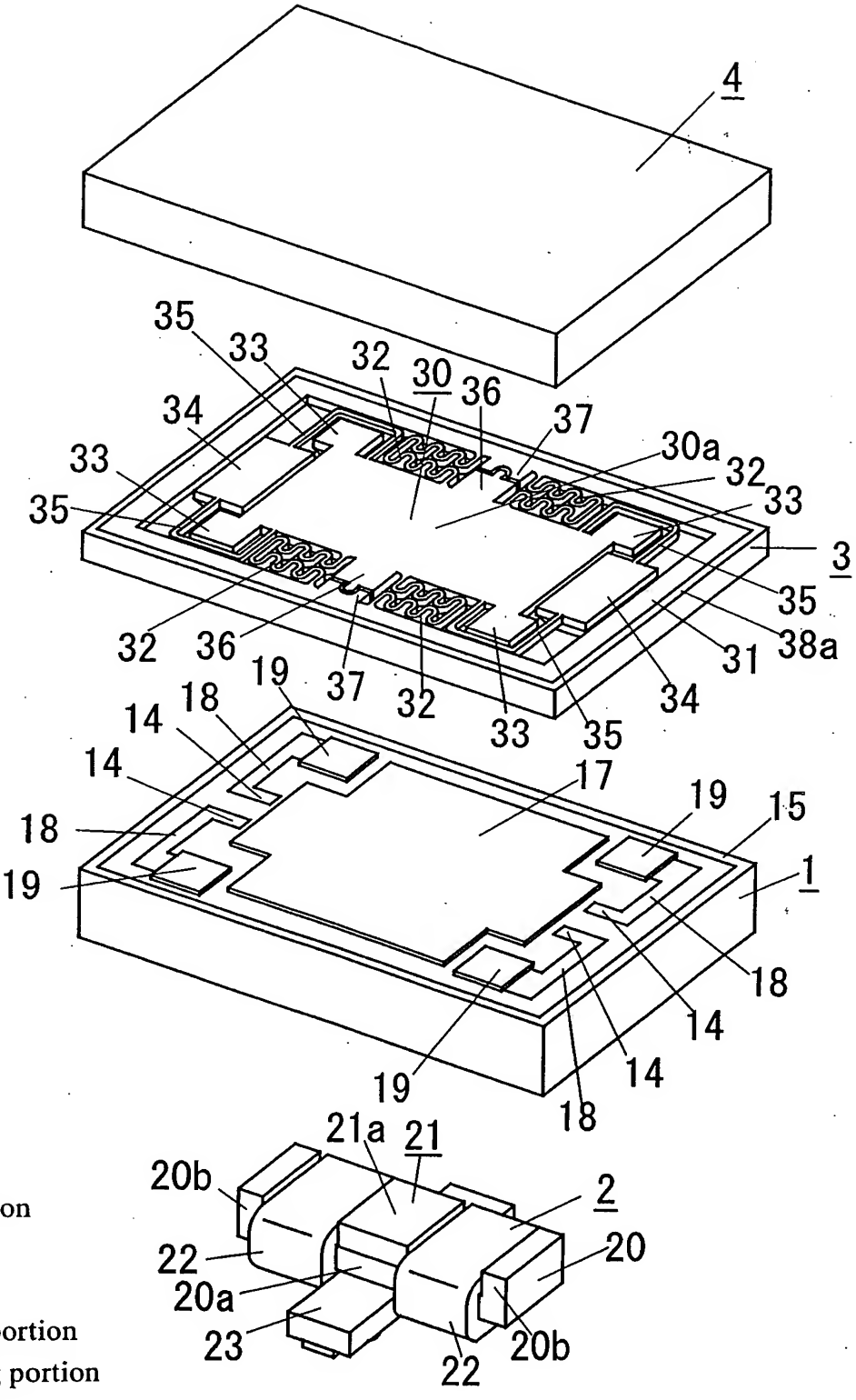


FIG. 1



1 Base substrate
2 Electromagnetic device
3 Armature block
4 Cover
10 Through-hole
14 Fixed contact
16 Storing hole
17 Lid member
20 Yoke
20a Coil winding portion
20b Leg piece
21 Permanent magnet
22 Coil
23 Printed board
30 Armature
30a Movable base portion
30b Magnetic member portion
31 Frame portion
32 Supporting spring
34 Movable contact base portion
35 Contact pressing spring portion

FIG. 3

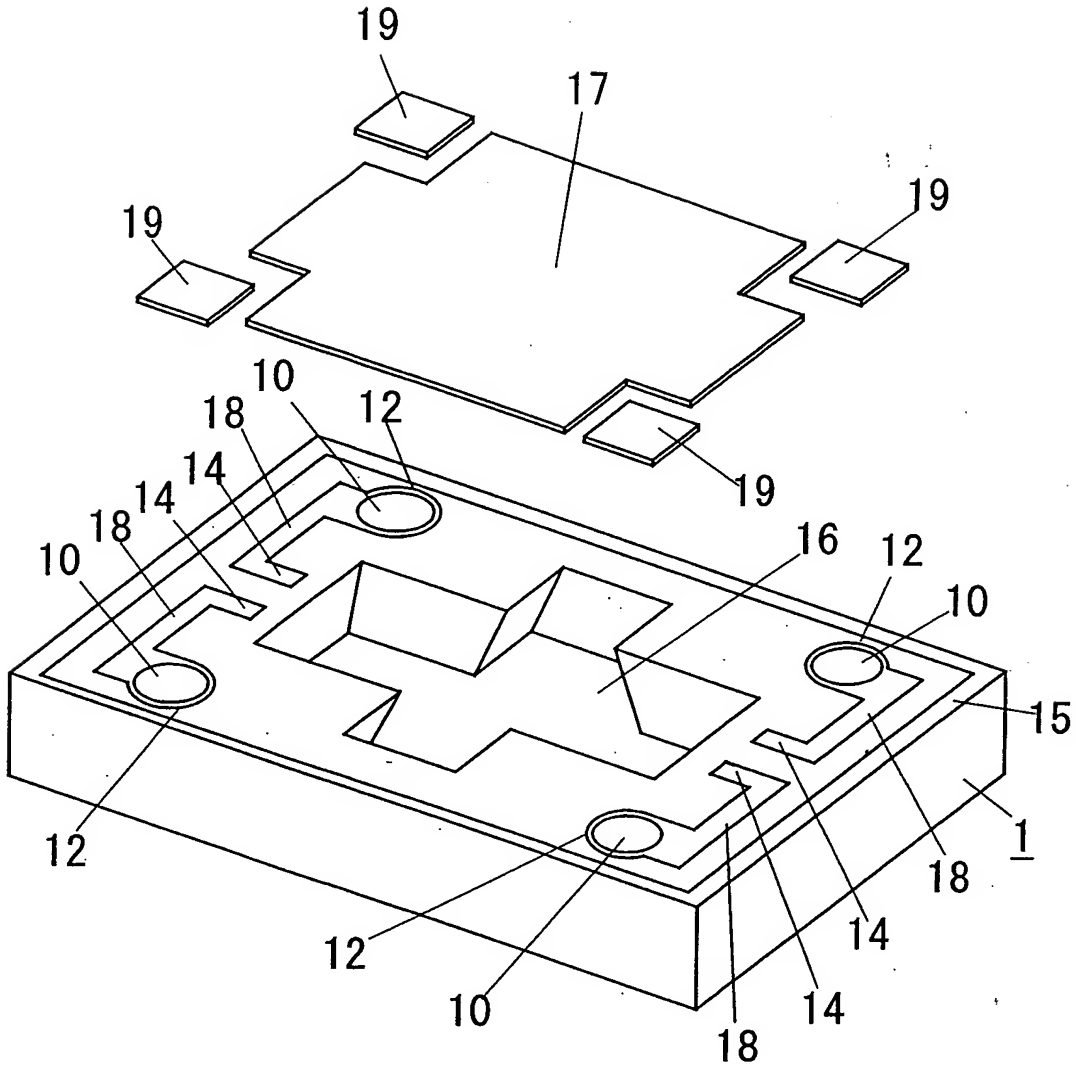


FIG. 4

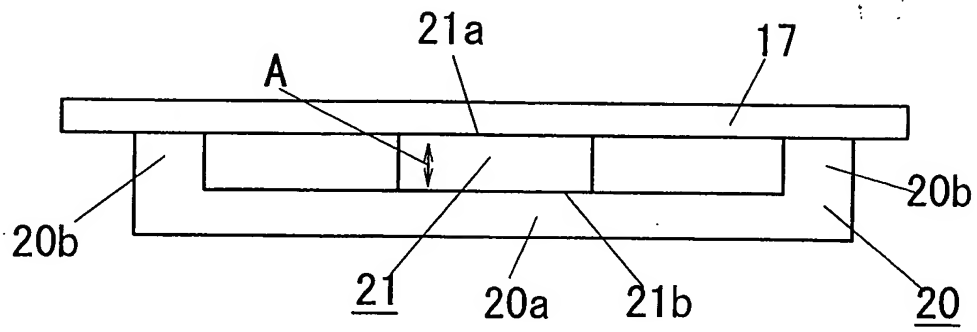


FIG. 5

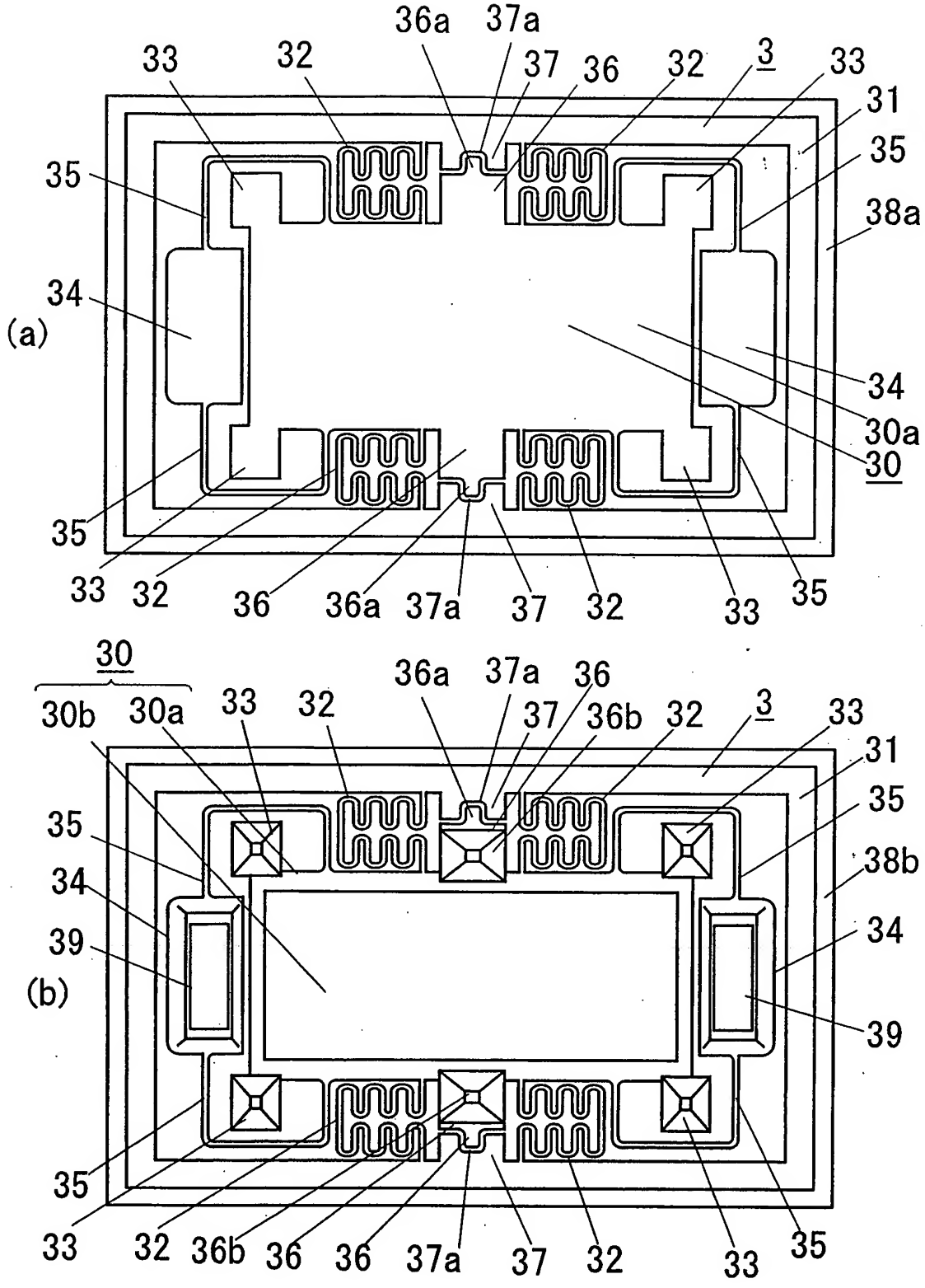


FIG. 6

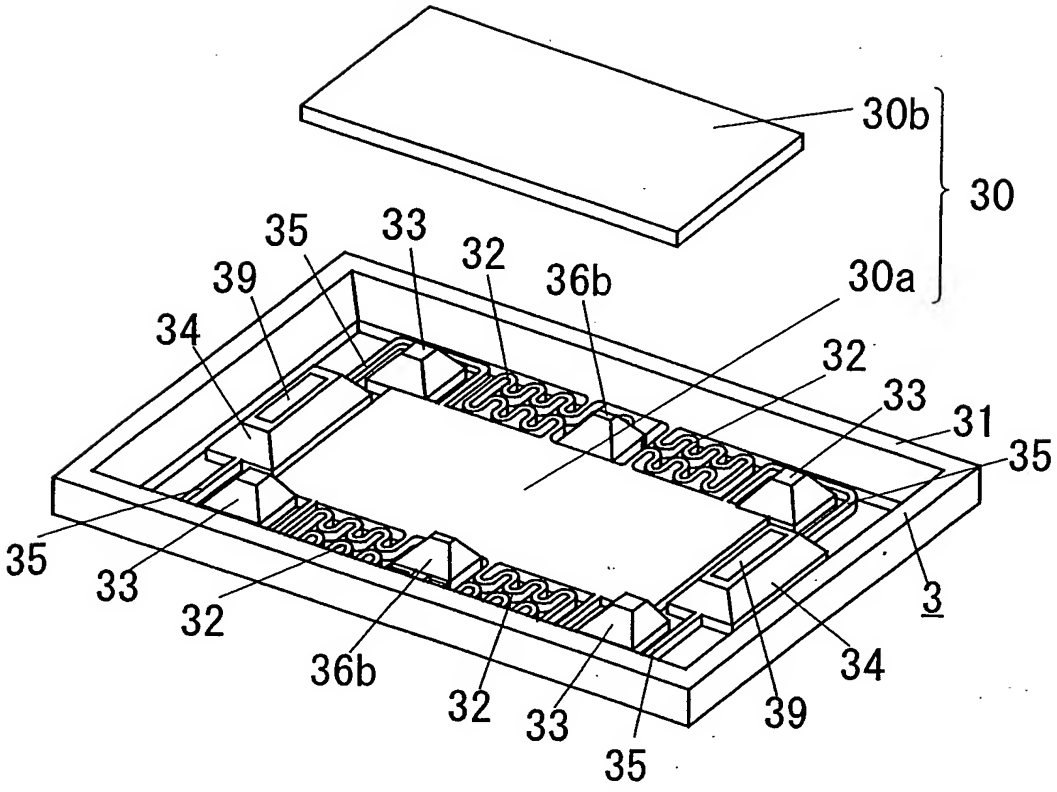


FIG. 7

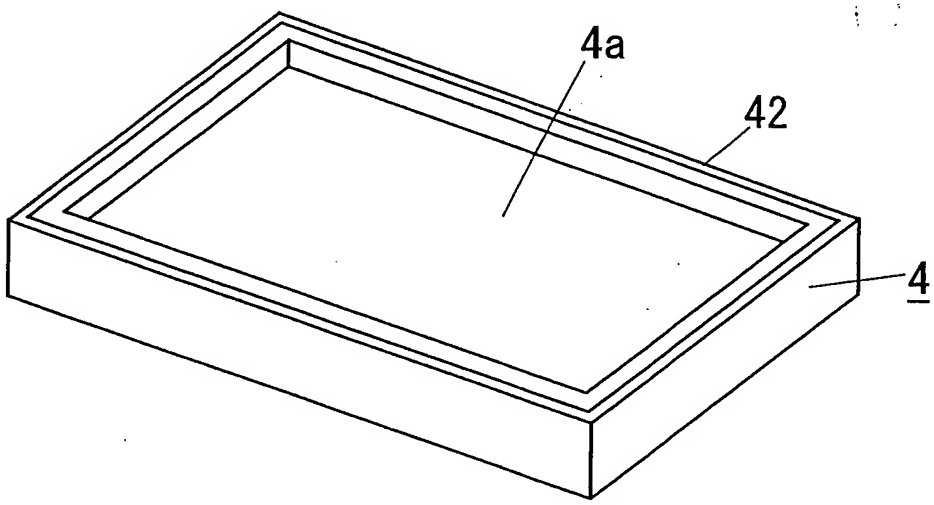


FIG. 8

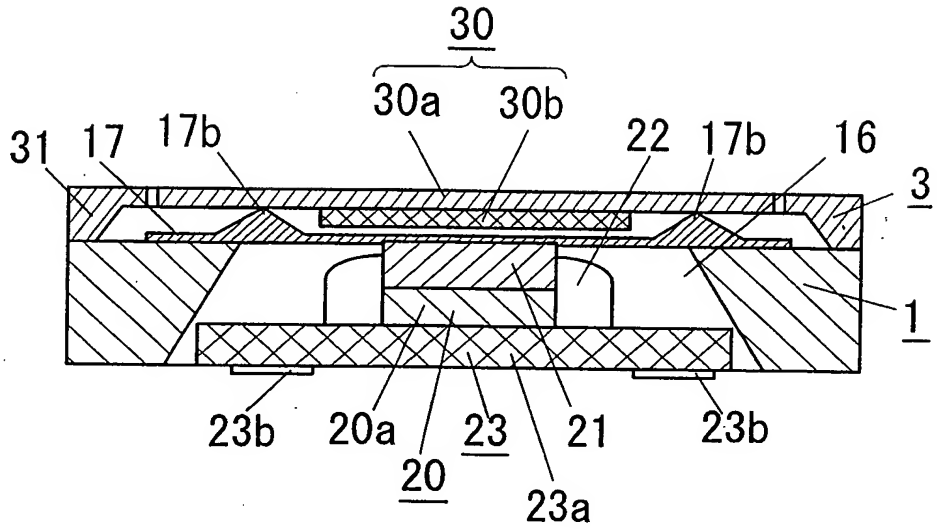


FIG. 9

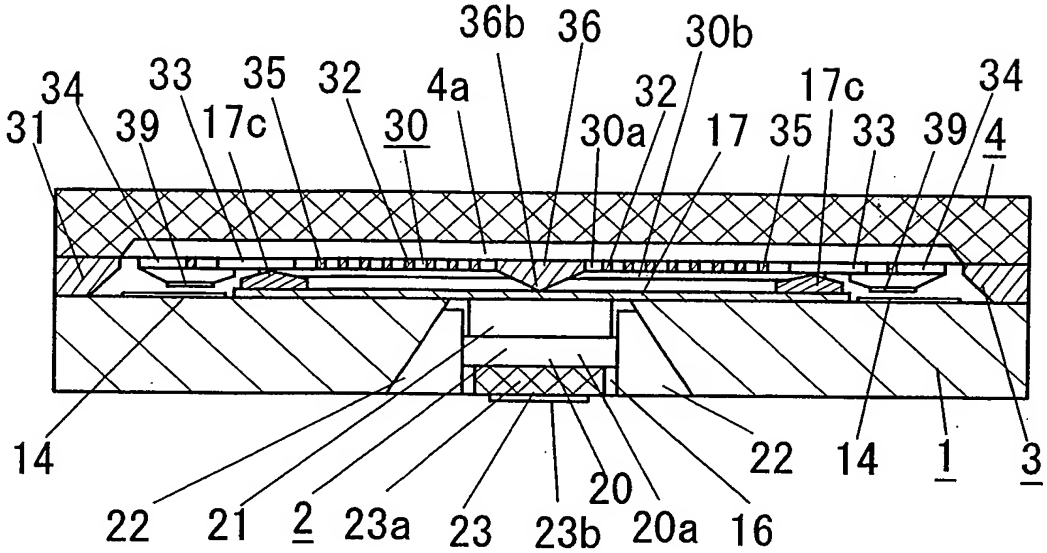

36b
36
30b
34
33
35
32
4a
32
17c
34
31
39
17c
30
30a
17
35
33
39
4
14
22
14
1
3
22
21
2
23a
23
23b
20
20a
16

FIG. 10

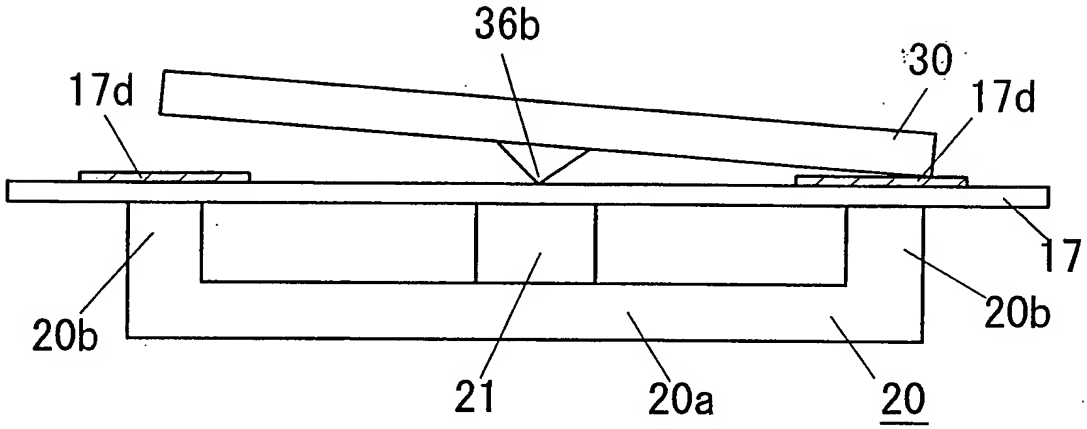


FIG. 11

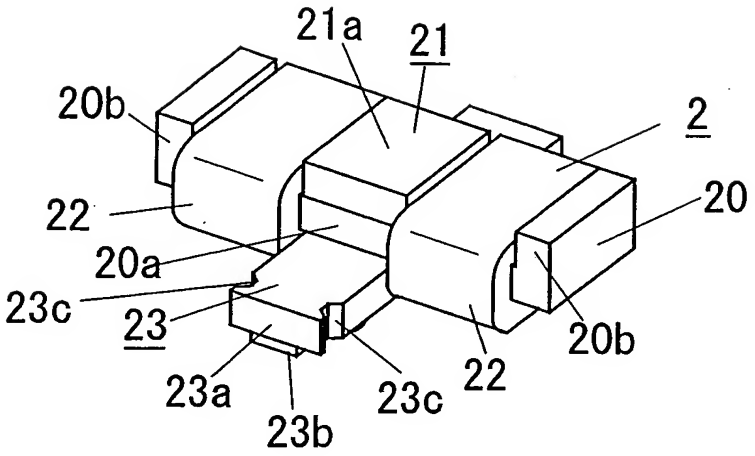


FIG. 12